Programme syllabus

Master's Programme, Machine Learning, 120 credits
Masterprogram, maskininlärning
120.0 credits

Valid for students admitted to the education from autumn 11 (HT - Autumn term; VT - Spring term).

This is a translation of the Swedish, legally binding, programme syllabus.

Programme objectives

Machine Learning is an area within Computer Science where computer systems are designed to learn from large sets of examples, similarly to the learning strategies of biological systems (like humans). Recently, Machine Learning has gained great importance for the design of search engines, robots, and sensor systems, and for the processing of large scientific data sets.

The focus of the Master’s program in Machine Learning is on mathematical foundations and methods for Machine Learning. The student can choose to study applications of this in Perception and Cognition or in Information Retrieval. For a closer description of the two tracks, see Appendix 2.

Knowledge and understanding

A Master of Science in Machine Learning will be able to:

- present a good knowledge of mathematical methods for Machine Learning, as well as how these are applied in either Perception and Cognition or in Information Retrieval applications,
- understand different Machine Learning problems deeply enough to select and apply suitable methods and computer tools to solve them,
- formulate and approach new Machine Learning problem settings in a scientific manner; in a creative, critical and systematic way.

Skills and abilities

A Master of Science in Machine Learning will be able to:

- work out solution strategies to different Machine Learning problems, knowing the capabilities and limitations of different methods and tools,
- work efficiently in a teamwork environment in groups with people from different scientific and engineering background,
- communicate with scientists and people active in engineering development in a competent manner both orally and in writing,
- follow and participate in research and development related to the chosen track.

Ability to make judgements and adopt a standpoint

A Master of Science in Machine Learning will be able to:

- critically judge a problem and in an independent manner acquire the information and knowledge that is necessary to establish a qualified opinion,
formulate and approach new Machine Learning problem settings in a scientific manner; in a creative, critical
and systematic way,
• identify the need for further knowledge in the field and take responsibility for keeping her/his personal
knowledge up to date.

In addition to this the similar objectives for master degree defined in the Higher Education Ordinance
(Högskoleförordningen) are applicable.

Extent and content of the programme
Machine Learning is a two-year (120 higher education credits) master program on the advanced level (second cycle). The instruction language is English. Some elective courses are given in Swedish.

The program consists of a basic curriculum followed by one of two tracks: (i) Perception and Cognition, and (ii) Information Retrieval. The courses in the basic curriculum of each track are compulsory and constitute a little more than half of the course work.

Eligibility and selection

Students from KTH Bachelor’s Programs Leading to Civilingenjör in Combination with the Machine Learning Program
A number of Bachelor’s programs at KTH give the degree of Civilingenjör in combination with Machine Learning. Students from these programs are accepted without selection to the Machine Learning program, provided that they have completed 150 higher education credits including a degree project and the courses listed below under specific admission requirements. Application is made before November 15.

Other Students
General admission requirements: See the KTH general admission requirements for Master’s programs, link below
Specific admission requirements: The prerequisites for the Master’s program in Machine Learning is a Swedish or foreign degree equivalent to Bachelor’s degree of 180 higher education credits, with a level in Mathematics and Computer Science equal, or higher, than that of the following courses at KTH: SF1604 Linear Algebra (or SF1624), SF1600 Calculus in One Variable (or SF1602, SF1625), SF1601 Calculus in Several Variables (or SF1603, SF1626), SF1906 Mathematical Statistics, and DD1340 Introduction to Computer Science (or DD1320, DD1321, DD1344).
Applicants must also provide a proof of good knowledge in English, equivalent to English B (Swedish school system).
Application is made at www.studera.nu before January 15.

Selection: The selection process is based on a total evaluation of the following selection criteria: grade point average (GPA), course work related to the program (e.g. in the fields of Machine Learning, Computer Vision, Image Processing, Speech Processing, Signal Processing, Neuroscience, Information Retrieval, or Data Mining), letter of intent, and references.


Implementation of the education

Structure of the education
The duration of the academic year is 40 weeks. The academic year at KTH is divided into four periods. Each period lasts approximately seven weeks, with at least 33 days of study. Each period and is followed by an exam period. Apart from these exam periods, there are three re-exam periods; before period 3, after period 4 and before period 1.

More information can be found at http://www.kth.se/student/schema/lasarsindelning-1.1007?l=en_UK
The first year in the program is mainly dedicated to the compulsory courses in the basic curriculum as well as those of each track. The second year mainly consists of elective track courses, freely selected courses, and the degree project.

**Courses**

The programme is course-based. Lists of courses are included in appendix 1.

The basic curriculum common to both tracks corresponds to around 25 higher education credits. In each track, there is an additional set of compulsory courses of around 25 higher education credits.

To obtain sufficient depth in a track, a student is, apart from the compulsory courses, required to complete at least three courses among the profile courses for the track in question. The remaining credits are received for freely elected courses. These courses may be chosen among the profile courses of the track, other second cycle courses at KTH, and language courses at KTH. First cycle courses at KTH can also be chosen, upon permission from the Program Director.

Courses are examined in many ways, for example by home assignments that are presented either using oral presentations or written reports, computer assignments, project work or traditional written exams.

After each course a student evaluation is performed and then analyzed by the course leader in the course analysis document, which is normally published on the web, see the KTH regulations of course analyses: http://intra.kth.se/regelverk/utbildning-forskning/grundutbildning/kursanalys

**Grading system**

Courses in the first and the second cycle are graded on a scale from A to F. A-E are passing grades, A is the highest grade. The grades pass (P) and fail (F) are used for courses under certain circumstances.

**Conditions for participation in the programme**

**Study Registration**

No later than November 15 and May 15 each academic year, respectively, the student is required to make a study registration and course selection at the CSC Program Office.

This study registration is required in order for the exam results to be registered.

**Pause in the Studies**

Students are considered pausing their studies if they do not participate in the educational activities during a period or more. The student has the right to return to the studies at a time agreed on, and has the right to participate in the examination of non-finished courses.

Pauses in the studies are reported on a form at the CSC Program Office. When returning to the studies, a new study registration has to be made (see above).

**Selection of Track**

Track selection is made during the first year. There are no limitations in terms of the number of students to each track.

**Selection of Courses**

The student is required to apply for all courses they wish to take during the next two periods. Applications should be made in the manner stated by CSC, before

- May 15 for periods 1 and 2,
- November 15 for periods 3 and 4.

Applications made after this date are only granted if there are vacancies in the courses.

Applications to language courses should be preceded by a level test.
In a few courses, the number of participants is limited. The selection to these courses is made by the School giving the course.

Course Registration

Registration to a course requires formal acceptance to a course. Applications should be made in the manner stated by CSC. The course registration is done at the School giving the course.

The student must register with the School giving the course at the start of each course, and also report to the School giving the course if the studies are discontinued.

Promotion to Second Year

At least 45 higher education credits have to be completed during the first academic year in order for the student to be promoted to the second year of the program.

Students who do not fulfill these requirements must make an individual course plan with their Program Officer.

Recognition of previous academic studies

Credits for studies at another university can be received. An application form can be found on the KTH Student pages.

The application form is submitted to the CSC Program Office.

For in-depth information about the KTH policy for crediting previous studies, see http://intra.kth.se/regelverk/utbildning-forskning/grundutbildning/prestationer/policy-for-tillgodoraknande-av-hogskoleutbildning-inklusive-bedomning-av-reell-kompetens-1.27200?l=en_UK

Studies abroad

Students of the program have the possibility to spend one or two semesters of study at a foreign university, or do their degree project abroad.

For more information, contact the person responsible for International Relations at CSC.

More information can also be found at http://intra.kth.se/regelverk/utbildning-forskning/grundutbildning/utbytesstudier/1.27222

Degree project

Students admitted to the program are required to perform an individual study in the form of a degree project corresponding to 30 higher education credits. At least 60 higher education credits must be completed before the start of the degree project. Of these, 40 higher education credits must come from the (common and track-specific) compulsory courses.

It is the responsibility of the student to find a suitable project task.


Degree

After completing the program, the student may apply for the Degree of Master of Science, in Swedish: teknologie masterexamen.

Information on the application process can be found on the KTH Student pages.

Requirements for the Degree of Master of Science
The Degree of Master of Science is obtained after completion of the Machine Learning program. The program is designed so that students, when they graduate, have fulfilled national requirements for a degree. This means that the students have completed courses comprising 120 higher education credits, of which at least 90 higher education credits are second cycle, and at least 60 higher education credits (including a 30 higher education credits degree project) constitute indepth studies in the main field of study.

See also the KTH regulations at http://intra.kth.se/regelverk/utbildning-forskning/grundutbildning/examina/1.27227?l=en_UK

Appendix 1 - Course list
Appendix 2 - Programme syllabus descriptions
Appendix 1: Course list

Master's Programme, Machine Learning, 120 credits (TMAIM), Programme syllabus for studies starting in autumn 2011

General courses

Year 1

Mandatory courses (75.0 credits)

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA2205</td>
<td>Introduction to the Philosophy of Science and Research Methodology</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DA2210</td>
<td>Introduction to the Philosophy of Science and Research Methodology for Computer Scientists</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2380</td>
<td>Artificial Intelligence</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2401</td>
<td>Neuroscience</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2423</td>
<td>Image Analysis and Computer Vision</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2427</td>
<td>Image Based Recognition and Classification</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2431</td>
<td>Machine Learning</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2432</td>
<td>Artificial Neural Networks and Other Learning Systems</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2447</td>
<td>Statistical Methods in Applied Computer Science</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2471</td>
<td>Modern Database Systems and Their Applications</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2476</td>
<td>Search Engines and Information Retrieval Systems</td>
<td>9.0</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

Conditionally elective courses

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD1368</td>
<td>Database Technology</td>
<td>6.0</td>
<td>First cycle</td>
</tr>
<tr>
<td>DD2257</td>
<td>Visualization</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2395</td>
<td>Computer Security</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DT2112</td>
<td>Speech Technology</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DT2118</td>
<td>Speech and Speaker Recognition</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DT2140</td>
<td>Multimodal Interaction and Interfaces</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>Course code</td>
<td>Course name</td>
<td>Credits</td>
<td>Edu. level</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------------------------------------</td>
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</tr>
<tr>
<td>EL2320</td>
<td>Applied Estimation</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>SF1841</td>
<td>Optimization</td>
<td>6.0</td>
<td>First cycle</td>
</tr>
<tr>
<td>SF2943</td>
<td>Time Series Analysis</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>SF2950</td>
<td>Applied Mathematical Statistics</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

**Supplementary information**

Compulsory courses year 1, for all students, are: DD2380, DD2423, DD2431, and *either* DA2205 *or* DA2210 (in Swedish).

Specialization streams are:

- Perception and Cognition
- Information Retrieval

Compulsory courses year 1, specialization stream **Perception and Cognition** are: DD2401, DD2427, and DD2432.

At least three of the conditionally elective courses within the chosen stream must be chosen. Year 1, specialization stream **Perception and Cognition**, the courses of this kind are: DD2257, DD2439 (not 2011/2012), DD2476, DT2112, DT2118, SF1841, SF2943, and SF2950. The conditionally elective courses DD2447, EL2320, and DT2140 are usually chosen year 2.

Compulsory courses year 1, specialization stream **Information Retrieval** are: DD2447, DD2471, and DD2476.

At least three of the conditionally elective courses within the chosen stream must be chosen. Year 1, specialization stream **Information Retrieval**, the courses of this kind are: DD1368 (in Swedish), DD2257, DD2427, DD2432, SF2943, SF2950, and SF1841. The conditionally elective course DD2395 are usually chosen year 2.

**Year 2**

**Conditionally elective courses**

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD221X</td>
<td>Degree Project in Computer Science, Second Cycle</td>
<td>30.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>SF288X</td>
<td>Degree Project in Optimization and Systems Theory, Second Cycle</td>
<td>30.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>SF299X</td>
<td>Degree Project in Mathematical Statistics, Second Cycle</td>
<td>30.0</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

**Supplementary information**

Compulsory course year 2, specialization stream **Perception and Cognition** is: DD2429.

At least three of the conditionally elective courses within the chosen stream must be chosen. Year 2, specialization stream **Perception and Cognition**, the courses are: DD2387, DD2397, DD2425, DD2447 (may also be chosen year 1), DT2140 (may also be chosen year 1), EL2320 (may also be chosen year 1), EN2202 and SF2940.
Specialization stream **Information Retrieval**, has these conditionally elective courses year 2: DD2387, DH2418 (in Swedish, may also be chosen year 1), DD2393, DD2395, DD2397, DD2429, DD2448 och SF2940.

### Track, Perception and Cognition (MAIA)

#### Year 1

#### Year 2

**Mandatory courses (6.0 credits)**

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD2429</td>
<td>Computational Photography</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

**Conditionally elective courses**

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD2387</td>
<td>Program System Construction Using C++</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2397</td>
<td>Applied Bioinformatics</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2425</td>
<td>Robotics and Autonomous Systems</td>
<td>9.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2447</td>
<td>Statistical Methods in Applied Computer Science</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DT2140</td>
<td>Multimodal Interaction and Interfaces</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EL2320</td>
<td>Applied Estimation</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EN2202</td>
<td>Pattern Recognition</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>SF2940</td>
<td>Probability Theory</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

**Supplementary information**

At least three of the conditionally elective courses must be taken during year 1 or year 2.

### Track, Information Retrieval (MAIB)

#### Year 1

#### Year 2

**Conditionally elective courses**

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD2387</td>
<td>Program System Construction Using C++</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2393</td>
<td>Protocols and Principles of the Internet</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2395</td>
<td>Computer Security</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2397</td>
<td>Applied Bioinformatics</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>Course code</td>
<td>Course name</td>
<td>Credits</td>
<td>Edu. level</td>
</tr>
<tr>
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<td>-----------------</td>
</tr>
<tr>
<td>DD2418</td>
<td>Language Engineering</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2429</td>
<td>Computational Photography</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2448</td>
<td>Foundations of Cryptography</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>SF2940</td>
<td>Probability Theory</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

**Supplementary information**

At least three of the conditionally elective courses must be taken during year 1 or year 2.
Appendix 2: Specialisations

Master's Programme, Machine Learning, 120 credits (TMAIM), Programme syllabus for studies starting in autumn 2011

Track, Perception and Cognition (MAIA)

Track, Information Retrieval (MAIB)